

MAE 433 – Computational Fluid Dynamics (CFD)
Mechanical and Aerospace Engineering Department – West Virginia University
Fall 2021; Tuesdays and Thursdays, 11:00 am – 12:15 pm, G11 ESB

Course Instructor: Dr. Christopher Griffin, Teaching Assistant Professor, MAE Department
Office Hours: MW, 2:00 – 3:00 PM; Th, 1:00 PM – 2:00 PM; or by appointment (open door policy)
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Course Description

This is an introductory course on modern CFD methods focused on the topics outlined above. An emphasis will be placed on learning practical skills to solve real world fluid dynamics problems using the CFD tools introduced in this course. Fundamental background information will be presented where appropriate. Commercially available software, namely ANSYS Fluent, will be used to demonstrate industrial solution approaches, complimented by basic coding assignments using MATLAB to better understand numerical techniques.

Course Pre-Requisites: MAE 316 and MAE 331 or MAE 335, Some experience with a common programming language (FORTRAN, **MATLAB**, C)

Course Textbook: An Introduction to Computational Fluid Dynamics: The Finite Volume Method, 2nd Edition by H. K. Versteeg and W. Malalasekera

Reference Textbook: Computational Fluid Dynamics: The Basics with Applications, by J. D. Anderson, Jr.

Course Topics

- Introduction to Modern CFD
- CFD Solution Procedures
- Governing Equations of Fluid Dynamics
- Mesh Generation and Boundary Conditions
- Basic Numerical Methods and Solution Techniques
- CFD Solution Analysis
- Turbulence Modeling
- Practical Guidelines for Specific Applications
- Advanced Topics in CFD

Grading

The final grade in the course will be assigned on the following basis:

Homework	15%
Project	25%
Midterm Exam 1	15%
Midterm Exam 2	15%
Final Exam	30%

Final letter grade will be based on 90-100 A; 80-89 B; 70-79 C, and so on.

NOTE: A final course score of 59.4% and below is a letter grade of “F”, whether you are graduating or not, have a job lined up or not. No exceptions.

Key Course Objectives

The objectives of this course are to introduce the fundamentals of computational fluid dynamics, develop the skills to transform the governing equations for numerical analysis, and apply this knowledge to the solutions of various fluid flow applications. A variety of solution methods will be discussed and practiced and hands-on experience with the commercial solver Fluent will be obtained.

Key Course Learning Outcomes

Students completing this course will:

- Have an understanding of the governing equations of fluid dynamics.
- Understand basic discretization techniques, grid generation, and CFD techniques using MATLAB.
- Have a familiarity with typical solution techniques.
- Understand some of the strengths and weaknesses of current CFD practices.
- Have some experience with a commercial CFD code.
- Appreciate the process of validation of CFD results.
- Possess an adequate background to take a more advanced graduate-level CFD course.

This course is a Key Course for the following ABET Outcomes:

Outcome 4. *An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts*

Outcome 7. *An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.*

Engagement Policy

There is no doubt we are in very unusual times. I appreciate all of you continuing your education despite the obstacles that we all are facing. I hope none of us gets sick, I also hope no one close to us gets sick, but I am prepared to work with anyone that may need to miss lecture or assignments due to COVID-19 or any other serious issue. I encourage you to reach out to me as soon as any issue arises so we can work out a plan to keep you up to speed and allow you to finish the course.

Assignment Policy

All assignments are due at the beginning of the assigned period, including electronically submitted material. Make-up exams and late assignments will **NOT** be accepted without **prior approval granted at least 2 days before the due date** from the instructor, consistent with WVU policies. Neat work is expected on all material submitted for grading (i.e. have to be able to read it to grade it). **Multiple sheets must be stapled, problems in the order assigned, and name and mailbox number must be on top of first page.** You may use engineering problem paper or standard notebook paper, but NOT scratch paper or paper torn from a spiral notebook and write on only one side of each page. All assignments turned in for grading must be your own individual work; copying homework is unethical.

Additional Exam Policy:

The following guidelines are imposed during every exam in MAE 433:

1. Absolutely **NO WIRELESS COMMUNICATION DEVICES** can be used during testing.
2. Exams are “closed book and notes”.
3. Students must maintain one empty seat between themselves and their neighbors (exceptions may be made if space is unavailable).
4. All midterm exams must be returned to the instructor and/or proctor by 12:20 pm; all final exams must be returned within the allotted two-hour exam period (exceptions will of course be made for students with documentation of additional requirements).

Teaching Philosophy

As the instructor, I will do everything possible to help you learn and understand the material, but you must do your part. The student is ultimately responsible for learning the material. It is not a trivial matter to earn an “A” in my course, but in the same respect, it is also difficult to receive an “F”.

As always, it is best if you can read the book material prior to lecture. But, equally important is to ask questions during lecture. If there are no questions, then I have to assume the material is easily understood and I can move on to the next topic. ASK QUESTIONS...

If you have a question on material, the textbook, homework, how I graded, or life in general, please come and see me as soon as possible. The earlier we can address a deficiency, the better. I am always open to meeting to discuss any questions and concerns.

Finally, I cannot stress enough the importance of doing all assigned work yourself. This includes reading, homework, projects, and self-study. I believe this approach is the only way to learn to address the following questions when solving a problem: a) what is the problem asking, b) what relevant theory do I need to apply, c) what is a representative system drawing for this problem, d) what assumptions and simplifications can I make, e) what local, initial or boundary condition information do I need, and f) what are the steps to solve this problem? **In other words, do not confuse copying solutions with asking your peers for help.**

Fall 2021 General Academic Calendar Key Dates

AUG 18	First Day of Classes	NOV 16	Last Day to Drop/Withdraw
AUG 24	Last Day to Modify Courses	NOV 20-28	Fall Recess (No Classes)
SEP 06	Labor Day (No Classes)	DEC 09	Last Day of Classes
OCT 07	Mid-Check Grades Due	DEC 10	Prep Day
OCT 07-08	Fall Break (No Classes)	DEC 16, 8AM	Final Exam

COVID-19 Statement

WVU is committed to maintaining a safe learning environment for all students, faculty, and staff. Should campus operations change because of health concerns related to the COVID-19 pandemic, it is possible that this course will move to a fully online delivery format. If that occurs, students will be advised of technical and/or equipment requirements, including remote proctoring software.

In a face-to-face environment, our commitment to safety requires students, staff, and instructors to observe the social distancing and personal protective equipment (PPE) guidelines set by the University at all times. While in class, students will sit in assigned seats when applicable and wear the required PPE. Should a student forget to bring the required PPE, PPE will be available in the building for students to acquire. Students who fail to comply will be dismissed from the classroom for the class period and may be referred to the Office of Student Conduct for further sanctions.

If a student becomes sick or is required to quarantine during the semester, they should notify the instructor. The student should work with the instructor to develop a plan to receive the necessary course content, activities, and assessments to complete the course learning outcomes.

Inclusivity Statement

The West Virginia University community is committed to creating and fostering a positive learning and working environment based on open communication, mutual respect, and inclusion.

If you are a person with a disability and anticipate needing any type of accommodation in order to participate in your classes, please advise your instructors and make appropriate arrangements with [the Office of Accessibility Services](https://accessibilityservices.wvu.edu/). (<https://accessibilityservices.wvu.edu/>)

More information is available at the [Division of Diversity, Equity, and Inclusion](https://diversity.wvu.edu/) (<https://diversity.wvu.edu/>) as well.

Sexual Misconduct Statement

West Virginia University does not tolerate sexual misconduct, including harassment, stalking, sexual assault, sexual exploitation, or relationship violence [[BOG Rule 1.6](https://policies.wvu.edu/finalized-bog-rules/bog-governance-rule-1-6-rule)] (<https://policies.wvu.edu/finalized-bog-rules/bog-governance-rule-1-6-rule>). It is important for you to know that there are resources available if you or someone you know needs assistance. You may speak to a member of university administration, faculty, or staff; keep in mind that they have an obligation to report the incident to the [Title IX Coordinator](https://titleix.wvu.edu/staff). (<https://titleix.wvu.edu/staff>)

If you want to speak to someone who is permitted to keep your disclosure confidential, please seek assistance from the [Carruth Center](#), 304-293-9355 or 304-293-4431 (24-hour hotline), and locally within the community at the [Rape and Domestic Violence Information Center](#) (RDVIC), 304- 292-5100 or 304-292-4431 (24-hour hotline).

For more information, please consult [WVU's Title IX Office](#) (<https://titleix.wvu.edu/confidential-resources>).

Academic Integrity

The integrity of the classes offered by any academic institution solidifies the foundation of its mission and cannot be sacrificed to expediency, ignorance, or blatant fraud. Therefore, instructors will enforce rigorous standards of academic integrity in all aspects and assignments of their courses. For the detailed policy of West Virginia University regarding the definitions of acts considered to fall under academic dishonesty and possible ensuing sanctions, please see the West Virginia University [Academic Standards Policy](#) (<http://catalog.wvu.edu/undergraduate/coursecreditstermsclassification>). Should you have any questions about possibly improper research citations or references, or any other activity that may be interpreted as an attempt at academic dishonesty, please see your instructor before the assignment is due to discuss the matter.

Statler College Policy of Academic Integrity

(Approved by the Statler College Academic Standards Committee, 28 March 2019)

Case	Violation	Penalty
1	Cheating or plagiarism on minor course element (e.g., quiz, weekly lab report, homework as specified in the syllabus)	Report of academic dishonesty Grade of zero on the entire minor course element Possible one-letter reduction in final grade
2	Cheating or plagiarism on a major course element (e.g., exam, project)	Report of academic dishonesty Grade of zero on the entire major course element Possible additional one-letter reduction in final grade Possible UF [†] recommendation Possible exclusion from further participation in class
3	Collusion on major course element	Report of academic dishonesty Exclusion from further participation in class Failure in the course Recommendation for UF [†]
4	Other (document alteration, tampering with records, etc.)	Report of academic dishonesty Grade of zero on the entire major course element Possible additional one-letter reduction in final grade Possible failure in the course Possible exclusion from further participation in class Possible UF [†] recommendation

* Dismissal from Statler College is permanent for Academic Integrity violations. Student conduct violations can be considered in dismissal.

† UF - Unforgivable F Grade; cannot be replaced under D-F repeat policy.

^π Separable sanctions (e.g., dismissal from Statler College, suspension, or expulsion from WVU) will be recommended for aggravated or second AI offenses.

[§] Warning letters may be issued from the Statler College or the WVU Office of Student Conduct.

Sanctions will be assessed at the instructor and at the college/university levels. Additional sanctions may be assigned at the level of the instructor, college, and/or university.

FORBIDDEN on Exams and Quizzes: The use of programmable calculators or smart devices (including smart-phones, smart watches, tablets, cameras, wearable devices, etc.) is prohibited unless specifically indicated by the instructor.

Disclaimer

The instructor reserves the right to deviate from the syllabus when a change is in the best interests of the class, as determined by the instructor.